INTELLIGENT NANOSCOPY: ONLINE OPTIMIZATION OF MULTIOBJECTIVE, MULTIPARAMETER AND MULTIMODAL STED IMAGING.

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Learning and memory at the cellular level involve the recruitment and reorganization of specific proteins at synapses, the femtoliter size connections between neurons. To study these molecular processes, taking place at the nanoscale, super-resolution microscopy, such as STED, is necessary. However, this technique comes with several layers of complexity. It requires the optimization of illumination and acquisition parameters, which depend on the fluorophores used, the biological structure, experimental conditions, and more. We introduce an online machine learning approach for finding well-performing parameterization simultaneously to the imaging task, and show its applicability on various proteins of interests, labeling densities, fluorophores and cell types. Furthermore, we propose a deep learning approach to automate the overall image quality evaluation and to articulate the expert preference among optimization objectives. The development of a fully automated system for optimizing imaging parameters significantly improves the results obtained with fixed and live-cell super-resolution imaging [1].

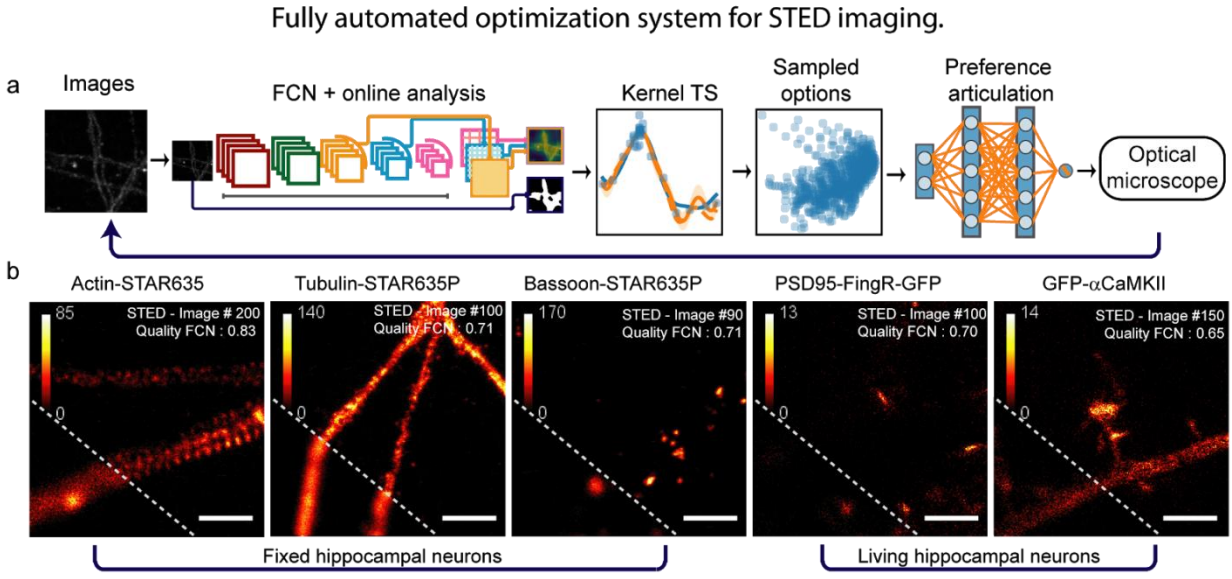

Figure 1: a) Scheme of the fully automated system where two neuronal networks automatically select the next imaging parameters (SNN) and rate the quality of the obtained images (FCN). b) Images acquired *without human intervention* during fully automated optimization sequences on fixed and live neurons. Scale bar 1 µm [1].

[1] Durand A, Wiesner T, Gardner M-A, Robitaille L-E, Bilodeau A, Gagné C, De Koninck P, Lavoie-Cardinal F. "A machine learning approach for online automated optimization of super-resolution optical microscopy." *Nat. Commun.* 2018;9(1):5247.